UDC 551.515.8:551.515.23(261.6)"1972.06.10/17" Agnes

## WEATHER NOTE

# Birth of Hurricane Agnes—Triggered by the Transequatorial Movement of a Mesoscale System Into a Favorable Large-Scale Environment [1]

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The formation of hurricanes is a process that meteorologists do not understand. Little can be said about an incipient hurricane until it has practically developed (often from an easterly wave) and shows up as a suspicious-looking large cloud mass detected by satellite. Theoretically, the problem of hurricane formation is far from solution. Perhaps some of the complexity of this problem arises from the fact that meteorologists are prone to look for a unique cause when in reality different storms may have different and perhaps multiple causes. Certainly, extratropical cyclones are known to develop from different combinations of interactions. It is the purpose of this note to suggest that the development of the devastating storm Agnes in the second 10 days of June 1972 may have resulted from a combination of events involving an antecedent massive cold air outbreak into the Tropics and, perhaps crucially, the migration of a "nucleating" cloud cluster of intense convective cells from the Southern Hemisphere Tropics into the Northern hemisphere.

I became aware of the existence of the latter nucleating cloud cluster while viewing a series of Advanced Technology Satellite (ATS 3) pictures kindly furnished me by the National Environmental Satellite Service. Ferris Webster of the Woods Hole Oceanographic Institution first drew my attention to a very active mass of convective clouds near the Isthmus of Panama on June 12, which subsequently could be followed northward into the area between Yucatan and Cuba where Agnes was first detected. With the help of other satellite pictures and charts of sea-surface temperature, I was able to hypothesize that the nucleus for Agnes appeared off the South American coast (around 5°S) in an area of abnormally warm surface water and then moved northward across the Isthmus of Panama until it reached the large-scale cloud environment generated earlier by an intense cold front. As it moved northward, the nucleating mass of convective cloud passed over an anomalously warm tongue of water with temperatures exceeding 80°F.

Documentation for the above statements appears in the satellite photographs reproduced in figures 1–6 and in the sea-surface temperature and temperature anomaly charts for June (fig. 7) furnished by the National Marine Fisheries Service (1972). The approximate day-to-day position of the center of the nucleating cloud mass is indicated on figure 7B. The strong cold front penetrating deep into the

[1] Woods Hole Oceanographic Institution, Mass., Contribution No. 2932

[2] Research conducted while author was Rossby Fellow at the Woods Hole Oceanographic Institution

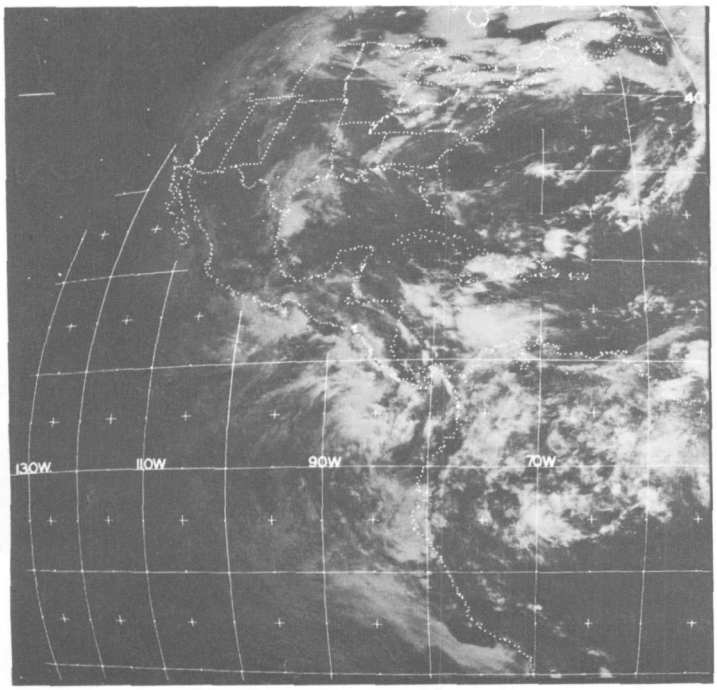


FIGURE 1.—ATS 3 satellite cloud picture for 1328 GMT on June 9, 1972.

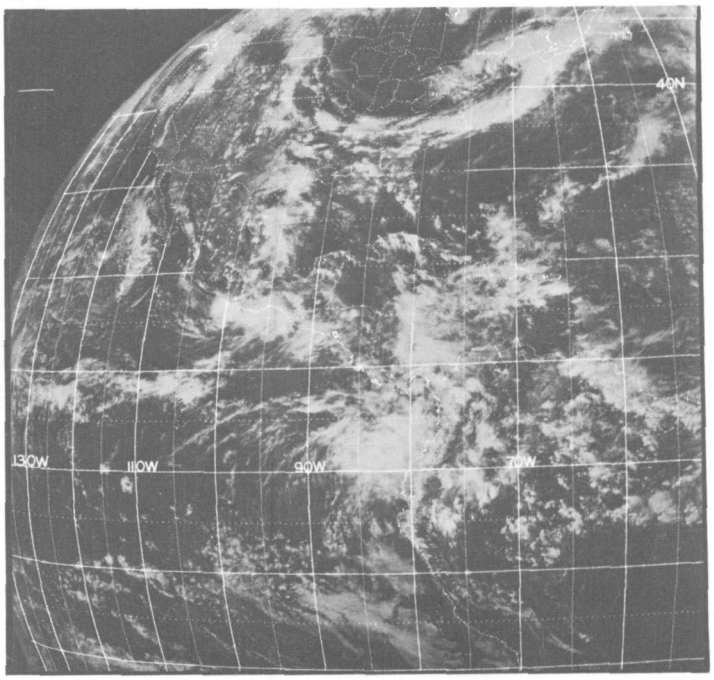


FIGURE 2.—Same as figure 1 for 1933 GMT on June 10, 1972.

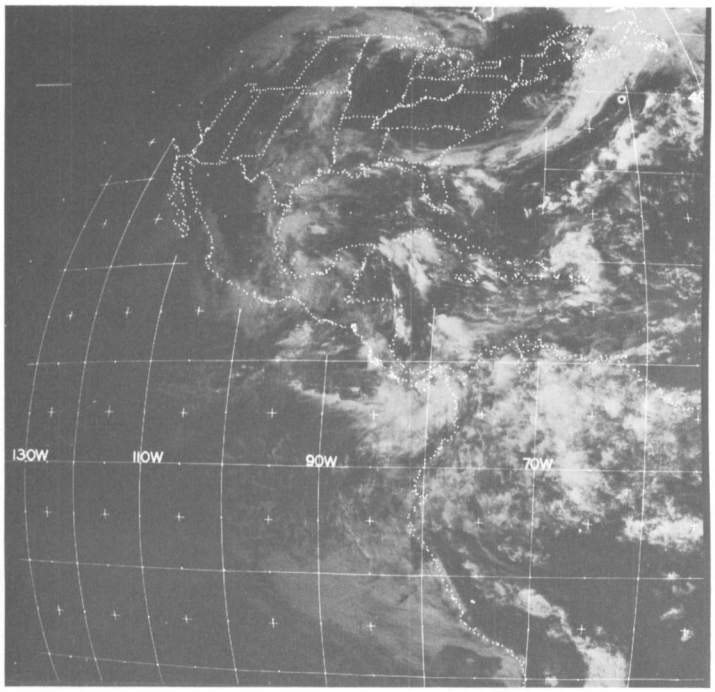


FIGURE 3.—Same as figure 1 for 1327 GMT on June 11, 1972.

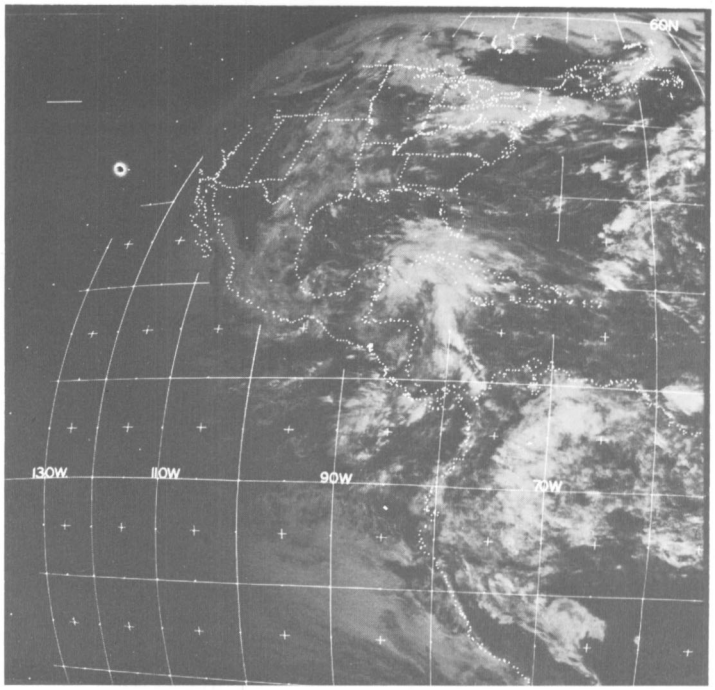


FIGURE 5.—Same as figure 1 for 1316 GMT on June 13, 1972.

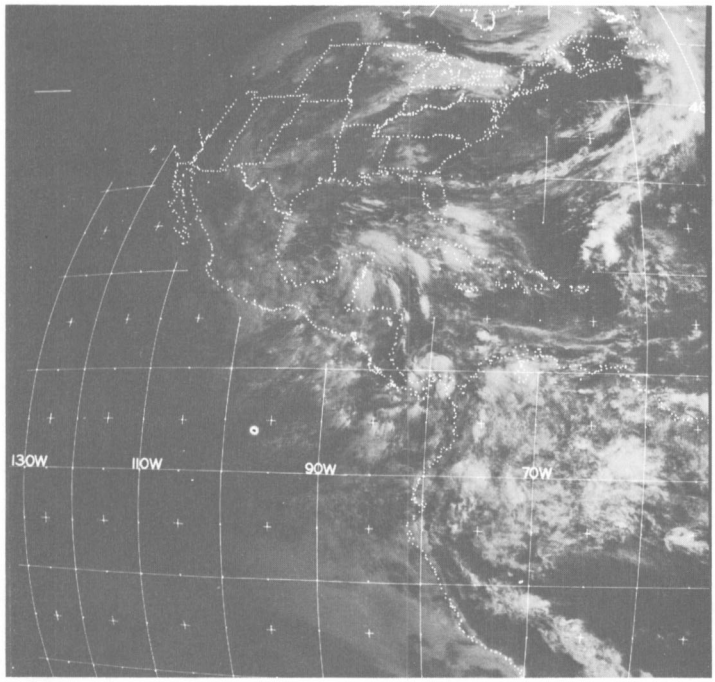


FIGURE 4.—Same as figure 1 for 1306 GMT on June 12, 1972.

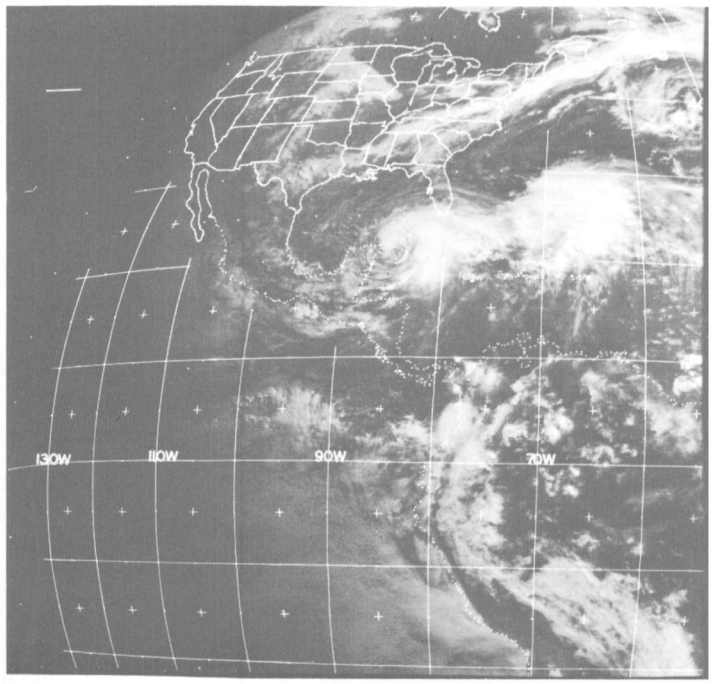


FIGURE 6.—Same as figure 1 for 1304 GMT on June 17, 1972.

Gulf of Mexico and western Caribbean with its attendant vast cloud mass is obvious from the satellite pictures (figs. 1–5).

This cold air outbreak set low-temperature records at many cities in the Eastern United States. A summary of the daily positions of the polar anticyclone, the cold front, and the amplifying 500-mb long wave that set the cold wave in motion is shown in figure 8. Note that the amplification first appeared off the Pacific coast with an unusually deep 500-mb trough and a southward plunging upper level cyclone.

Apparently, the large-scale convective cloud system associated with the cold front, the general cyclonic vorticity field, and the implied high moisture content aloft provided a favorable large-scale environment for triggering the hurricane by the nucleating intense mesoscale cloud system arriving from the south over anomalously warm water.[3] Of course, time would be required for the development of a hurricane—apparently from June 13 to 17.

[3] This warm water was a manifestation of the "El Niño" which has had ecological impact on the fisheries off Peru, as described in the New York *Times*, Aug. 12, 1972, p. 29.

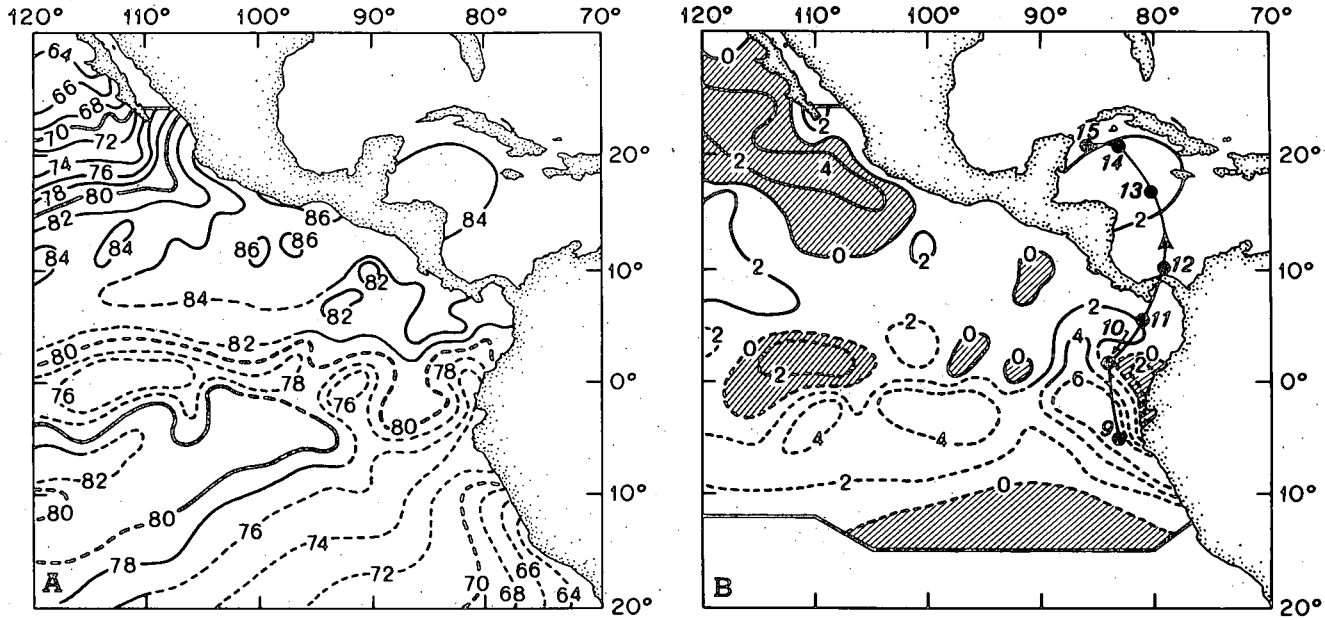


FIGURE 7.—Sea-surface (A) temperatures (°F) and (B) temperature anomalies (°F) for June 1972. Western Caribbean values are from the Fleet Numerical Weather Center, Monterey, Calif. The shaded areas in (B) are colder than normal, and the line with the heavy arrow connects daily positions of the center of the convective cloud mass shown in figures 2–5.

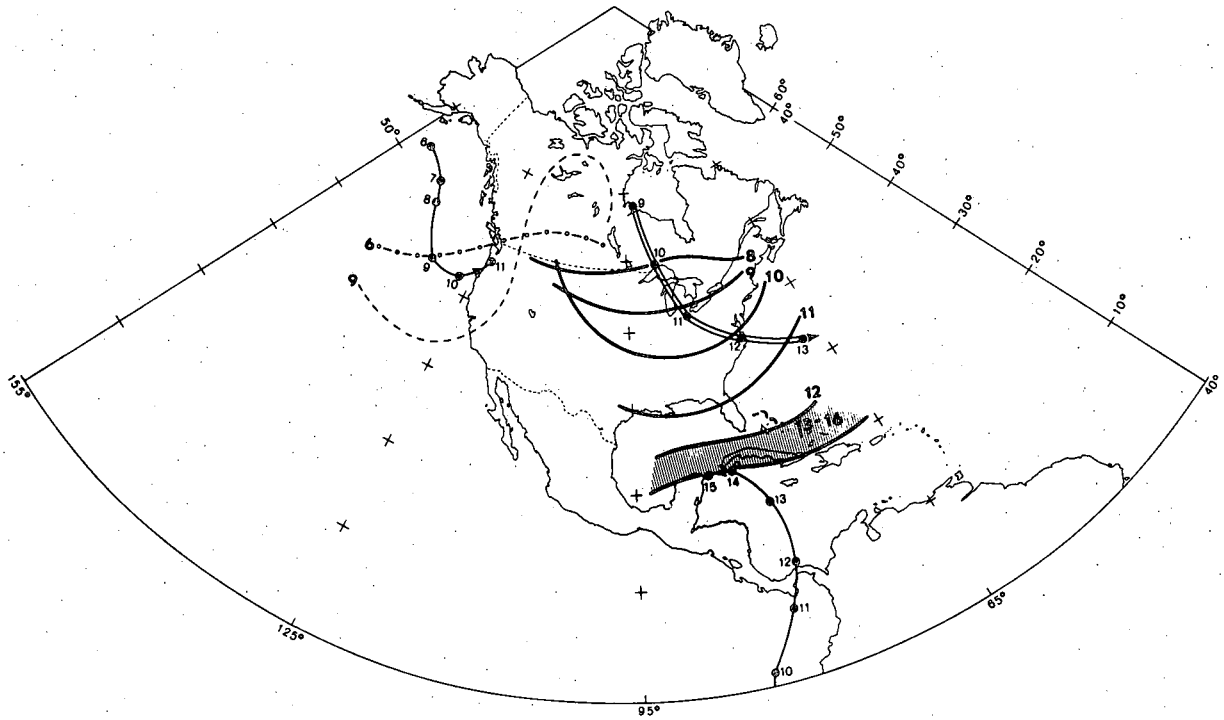

FIGURE 8.—Daily positions of the polar outbreak front over the Eastern United States during June 1972. (Positions from June 8 to 11 are from National Weather Service weather maps and those from June 12 to 16 were estimated by author.) The open arrow connects daily positions of the center of the polar anticyclone. The path of the cloud nucleus from June 10 to 15 is copied from figure 7B. In the Pacific, daily positions of the 500-mb cyclone, and on the 6th and 9th the 18,700-ft contour of the 500-mb surface, are plotted.

The unusual course of Agnes after landfall and the exceptionally heavy rainfall associated with its extended land trajectory are events that the author, in a later, more detailed report, hopes to demonstrate are related to large-scale (almost hemispheric) interactions building up over a 4- to 5-mo interval.[4] It is hoped that the present note will encourage students of hurricanes to examine the evidence in much greater detail.

[4] To appear in the July 1973 issue of the *Quarterly Journal of the Royal Meteorological Society*.


## ACKNOWLEDGMENT

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## REFERENCE


National Marine Fisheries Service, NOAA, Southwest Fisheries Center, *Fishing Information*, No. 6, La Jolla, Calif., June 1972.



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